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ANNUAL REPORT -- FY 1987

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Cover--Dominance relationships among bighorn rams were examined to quantify structure, development, and reproductive correlates of rank. Rams exhibited highly stable hierarchies that were strongly correlated with age. Dominance relationships were not evident until after 1 year of age. Behavioral interactions were closely tied to dominance rank. Direct reproductive benefits of high rank, in terms of more breeding opportunities, were obvious.

Photo by Bart O'Gara



Rodents killed by haying machinery attract ravens and coyotes to hayfields. Therefore, poisons should not be applied during haying operations or for a period of at least 1 week thereafter to kill ground squirrels.

Photo by Bart O'Gara

ANNUAL REPORT

of the

MONTANA COOPERATIVE WILDLIFE RESEARCH UNIT

University of Montana

Missoula, Montana

to

UNIVERSITY OF MONTANA

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS


WILDLIFE MANAGEMENT INSTITUTE

U.S. FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR

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Respectfully submitted,

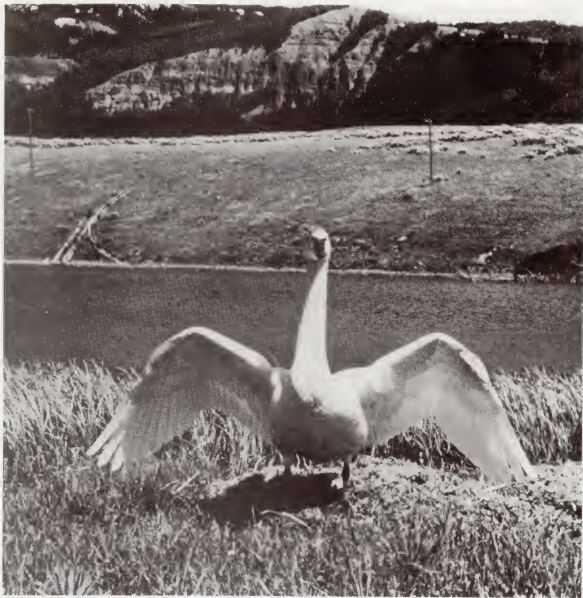


Bart W. O'Gara, Leader



Joe Ball, Ass't. Leader

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All trumpeter swans of the Rocky Mountain Population are dependent upon one very harsh winter range. Many birds are severely stressed and emaciated by winter's end, and the entire population may be vulnerable to a disease outbreak or the effects of a severe winter with extensive ice formation. The migratory Canadian trumpeters are vulnerable to severe winter weather in the Tristate area, but as they slowly migrate north during March and April, they apparently gain the nutrient reserves required for successful production. The Canadian migrants surpass the nonmigratory Tristate trumpeter in all measures of reproductive success. Without the traditional knowledge of more southerly winter and spring habitats, the nonmigratory Tristate trumpeters are dependent exclusively on harsh, high elevation winter and spring habitats. During most years, many pairs appear unable to obtain the nutritional reserves needed to provision a normal clutch and to produce viable cygnets. Most of the Tristate subpopulation depend upon the supplemental winter feeding at Red Rock Lakes NWR to survive the winter. The reproductive success is strongly influenced by the highly variable spring habitat conditions. The Tristate trumpeters will remain dependent upon supplemental feeding and extremely vulnerable to fluctuating spring weather and habitat conditions as long as they remain nonmigratory.

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MONTANA COOPERATIVE WILDLIFE

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U.S. Fish and Wildlife Service

Bonneville Power Administration
Boone and Crockett Club
Bureau of Indian Affairs
Bureau of Land Management
Camp Fire Conservation Club
Chempar Products Division of Lipha Chemicals
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Double Four Corporation
Grizzly Bear Recovery Coordination Office
Idaho Department of Fish and Game
Institute of Biology, National Taiwan Normal
International Snow Leopard Trust
Kirthar National Park, Pakistan
Michael Murphy Foundation
Missoula County Rodent Control Board
Montana Department of Agriculture
Montana Power Company
National Parks and Conservation Association
National Rifle Association
National Wildlife Federation
North American Foundation for Wild Sheep
Northwest College and University Association for Science
Pakistan Forest Institute
Sind Wildlife Management Board, Pakistan
The Trumpeter Swan Society
UNESCO

U.S. Department of Energy (INEL Site)
U.S. Fish and Wildlife Service
 Benton Lake NWR
 Division of Refuges
 Migratory Bird Management Office
 National Bison Range
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 Sheldon-Hart NWR
 Office of International Affairs

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Western Plateau Institute, Academia Sinica
Wildlife Institute of India
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PERSONNEL NOTES

The following personnel joined the Unit on nongraduate student appointments of varying length:

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John Cowardin	Paul Johnson
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CSKT-RPA Goose Studies

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Dennis Mackey	Bill Swaney

BIA-Kerr Dam Wildlife Studies

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Richard Johnston	Laurens van Miltenburg (V-S)
Jamie Jonkel (V-S)	

(V-S) = Volunteer with subsistence allowance.
All others are paid positions.

Work Study Students

Hank Huigen
Darren Johnson
Doug McAlister
Tom Radandt

Tarn Ream
Scott Snelson
Amy Workman



Sites along the shoreline of Flathead Lake were baited with wheat to attract Canada geese to rocket net sites. In spite of harsh, rocky substrates and intense foraging by adults on the wheat grains, these sites grew substantial stands of wheat in the spring. Broods foraged in these stands in the spring because they provided nutritious, succulent forage and because traveling between the security of open water and upland grazing areas involved high risk of predation. Subsequent tests of wheat planting on the barren zone between high- and low-water marks verified that wheat grew, and was utilized by broods, on all test sites from cobbles through sandy beaches.

Photo by BPA

ABSTRACT

Easter-Pilcher, Andrea L., M.S., August 1987

Wildlife Biology

Forage Utilization, Habitat Selection and Population Indices of Beaver in Northwestern Montana (80 pp.)

Directors: L. H. Metzgar and D. H. Pletscher

Field investigations were conducted on beaver (*Castor canadensis*) in northwestern Montana from June 1985 through December 1986. General habitat and population sampling of 550 km of waterway was initiated on 1 July 1985 and completed on 31 August 1986. Generally, areas having common and abundant amounts of old and current beaver use exhibit stream and vegetation characteristics that seem to have the most influence on presence and abundance of northwestern Montana beaver (Easter-Pilcher in prep).

Intensive habitat and population sampling at 10 randomly selected colony sites and 10 stratified random sites in each of the Swan, Clearwater and Fish Creek drainages was initiated in September 1986 and completed in December 1986.

Forage utilization plots (360) were run on these occupied and unoccupied sites. Application of the Chi-square goodness of fit test and Bonferroni Z confidence intervals showed a general preference for small stems (less than 5.0 cm in diameter) with willow, cottonwood, alder and dogwood as the preferred species, respectively. The data also reveal a trend towards preference of medium-size stems (2.5-5.0 cm) over smaller stems (<2.5 cm) farther from the water.

Colony size was assessed through nocturnal observation with infrared night-vision goggles. Colony size was regressed with various population indices which included number of dams, weighted tracks, number of stems cut, and cache volume. Cache volume accounted for the only significant source of variation in colony size ($R^2 = 0.68$).

A discriminant function model for winter colony site selection was developed from measured stream and vegetation characteristics at the occupied and random sites. Water depth, slope distance between the high and low water marks, and availability of understory willow correctly classified 96% of the occupied sites and 92% of the random sites.

Colony size was regressed with principal components of the habitat variables. Water depth, stream width, availability of willow, slope distance between low and high water marks, vertical water fluctuation (vertical distance between high and low water marks), and the presence of a confluence were positively correlated to colony size.



ABSTRACT

Gniadek, Steven J., M.S., Spring 1987

Wildlife Biology

Elk and Cattle Relationships on Summer Range in Southwestern Montana

Director: B. W. O'Gara

Research was conducted during the summers of 1984 and 1985 in four rest-rotation pastures of the Wall Creek Grazing Allotment in the Gravelly Range of southwestern Montana. Most cattle use was in meadows and use of closed canopy forest was greatest at the edges. Most cattle use was on gentle to moderate slopes, with only 5% on slopes of 30% or more. Water distribution was a major determinant in cattle distribution, with three-fourths of the cattle observed within 200 m of water.

Elk appeared to tolerate cattle in a pasture or in a portion of a pasture only in low densities. Elk generally avoided grazed pastures, making relatively greater use of rested pastures and of grazed pastures before and after grazing. Elk also tended to segregate from cattle by use of higher elevations in grazed pastures. Elk made greater use of forest cover and steeper slopes than cattle. However, this difference appeared to be unrelated to cattle grazing, with elk using more forest cover and steeper slopes in both grazed and ungrazed pastures. Meadow sites heavily used by cattle during the previous year were avoided by elk during the early summer. Elk were rarely observed in close proximity to cattle and probably made greater use of grazed pastures during nocturnal hours when cattle were mostly bedded.

Closing of gates following cattle rotations between pastures permitted elk to reuse pastures after cattle grazing. Gates left open after rotations allowed cattle simultaneous use of more than one pasture and limited reuse by elk.



ABSTRACT

Hass, Christine C., M.A., November 1986

Zoology

Play Behavior and Dominance Relationships of Bighorn Sheep on the National Bison Range (96 pp.)

Director: D. A. Jenni

A 27-month study of bighorn sheep (*Ovis canadensis*) on the National Bison Range, Montana, focused on two aspects of social behavior: play behavior and dominance relations. Data collected from the lambs supported the Motor Training Hypothesis for the function of play behavior, but not the Social Cohesion or Social Competition Hypotheses. Male lambs played more than female lambs, and lambs chose partners closest to them in size and age. The most common components of play were those patterns used in intraspecific conflict and predator evasion. The number and sex of available play partners influenced the amount of play more than did maternal investment. Peak play periods coincided with the period of most rapid growth. These data are consistent with the hypothesis that play behavior, under certain environmental and social constraints, provides lambs with immediate, as well as delayed, motor training benefits.

Dominance relationships among bighorn rams and ewes were examined to quantify structure, development, and reproductive correlates of rank. Both rams and ewes exhibited highly stable hierarchies that were strongly correlated with age. Dominance relationships were not evident until after the sheep were one year old. Behavioral interactions, particularly among the rams, were closely tied to dominance rank. Direct reproductive benefits of high rank, in terms of more breeding opportunities, were obvious for rams. No reproductive benefits, in terms of lamb weight, lamb sex, date of estrus or lambing, nor nursing duration or rate, could be found for ewes.



ABSTRACT

Knick, S. T., Ph.D., 1987

Zoology

Ecology of Bobcats Relative to Exploitation and a Black-tailed Jack Rabbit Decline in Southeastern Idaho.

Director: I. J. Ball

Bobcat (Felis rufus) population responses to exploitation and a decline in black-tailed jack rabbit (Lepus californicus) populations were studied in southeastern Idaho from 1982 through 1985. Bobcat social organization during peak jack rabbit densities consisted of a territorial system with little intra- and much inter-sexual range overlap. Possession of a territory appeared necessary for females to raise young. None of the 12 marked females <15 months of age raised kittens even though some were physiologically capable of breeding. Kittens moved independently from their mother within the natal range by 9 months of age and dispersed at a mean age of 14.5 months. Most dispersals (16/17) were <35 km from the natal range and were to habitats similar to the natal range. Harvest effects were determined by comparison of an unharvested population on the Idaho National Engineering Laboratory (INEL) with a harvested population in the Box Canyon region of the Big Lost River. The harvested population contained a higher proportion of yearlings and a lower proportion of adults than the unharvested population. Because yearlings did not reproduce, the harvested population was maintained solely by immigration from surrounding regions. I studied the functional and numerical responses by bobcats during the 2nd through 5th years of a decline in black-tailed jack rabbit numbers. During the jack rabbit decline, bobcats ate more cottontail (Sylvilagus nuttallii) and pygmy (S. idahoensis) rabbits during winters and small mammals during summers while the proportion of jack rabbits in their diet decreased. To conserve energy, denning females stayed closer to the den, and traveled shorter total distances when small rodents were the primary prey in 1983 compared to 1982 when jack rabbits were eaten. After jack rabbits declined, bobcat recruitment ceased because fewer females raised litters and kitten survival was reduced. As a result, bobcat densities declined at an annual rate of $\lambda = 0.52$ between 1982 and 1985 in both study areas. Adult survival remained the same during the jack rabbit decline except for winter 1984-85 when 2 adult females starved to death. As jack rabbit populations declined, the average size of the home range increased and by 1984-85 was 5 times larger than in 1982. Bobcats made extra-territorial forays during winters of the decline to areas of jack rabbit aggregations or to lava flows. Inverse density-dependent predation on jack rabbits in aggregations during their decline could act to increase the amplitude of the cycle. Computer simulations of female bobcat populations were used to determine yield at different harvest intensities. Recommended harvest rates were <20% of the fall population. Increases in mortality to productive females that orphaned kittens had a greater impact on yield than did increases in kitten mortality. The predicted size of refugia necessary to maintain the population suggested that it was necessary to buffer some territories from the refuge edge.



Bobcat social organization during peak jack rabbit densities in southeastern Idaho consisted of a territorial system with little intra- and much inter-sexual range overlap. Possession of a territory appeared necessary for females to raise young. During a jack rabbit decline, bobcats ate more cottontail and pygmy rabbits during winters and small mammals during summers while the proportion of jack rabbits in their diet decreased. To conserve energy, denning females stayed closer to the den, and traveled shorter total distances when small rodents were the primary prey. Bobcats made extra-territorial forays during winters of the decline to areas of jack rabbit aggregations or to lava flows.

Photo by Steve Knick

ABSTRACT

Everett, Rebecca J., M.A., December 1986

Zoology

Population Genetics of Arctic Grayling (Thymallus arcticus) of Montana (82 pp.)

Director: F. W. Allendorf

Electrophoretic and morphological methods were used to describe the amount and pattern of genetic variation in populations of Arctic grayling from Montana. Samples representing Alaska and Canada populations were used for comparison.

The amount of genetic variation, measured as average heterozygosity, was 3.28% in Montana populations, 2.11% in Alaska fish, and 5.96% in the Canada-derived stock. Of 34 loci studied, 7.8% were polymorphic in Montana populations versus 11.8% in the Canada sample.

Montana grayling were historically a river-dwelling species. Current stocks are mainly in lakes, and are of hatchery origin or have been supplemented by stocking. It was expected that all populations would be very similar genetically due to the shared common origin or that differences among populations would reflect adaptations to different environmental conditions.

The genetic identities among all populations studied are high. Nevertheless, there are significant differences in allele frequencies among populations. Regardless of habitat type, the hatchery populations are most closely related to one another whereas the Big Hole River Drainage populations, with native fish, are distinct.

There is no evidence of introgression with transplanted Arctic stocks. High frequency variants observed in the non-native populations would make mixed stocks detectable.

The amount of variation in seven morphological traits, measured as a coefficient of variation, was uncorrelated with average heterozygosity. The relationships of populations indicated by morphological data showed little or no correspondence with stocking records or isozyme data.

Management strategies for conservation of this threatened species should reflect the presence of genetically unique stocks that should be preserved.



ABSTRACT

Malik, M. Muntaz, M.S., Spring 1987

Wildlife Biology

Management Plan for Wild Artiodactyls in North West Frontier Province, Pakistan (142 pp.)

Director: B. W. O'Gara

The overall wildlife management objectives for North West Frontier Province, Pakistan, should include the protection, preservation, conservation, and management of wild artiodactyls. This should be done in a way that reduced populations are restored and wild game is utilized to achieve "human goals" on a sustained basis without threatening species survival. This should involve: protection and preservation of endangered species to build up populations of musk deer, barking deer, Indian chinkara, straight-horned markhor, and hog deer; protection and conservation of flare-horned markhor, urial, Himalayan ibex, and gray goral, providing limited sport to hunters who can pay high fees for permits; involving local people in conservation programs through provision of incentives and environmental education; and improving depleted wildlife habitats.

Surveys are needed to determine the distribution and population status of wild artiodactyls and identify areas with potential for management as reserves. Here the term "reserve" is used in a general sense and includes national parks, wildlife sanctuaries, and reserves. Sizes of reserves in NWFP must be determined by the biological requirements of species, land tenure systems, and socioeconomic condition. Biological considerations include the habitat condition, size of home ranges of individuals, migration patterns, distance from the nearest similar habitat, and the intensity of hostility on the intervening environment matrix.

Manpower simply is not available to protect wildlife throughout Pakistan, thus the need for protected reserves. Recommendations are made for location of reserves for each species and for management of species that ranges from complete protection of endangered species to heavy exploitation of wild boar to alleviate crop damage.



ABSTRACT

Kraft, Susan K., M.S., Winter 1987

Wildlife Biology

Ecology of Mule Deer in the Upper Missouri River Breaks, Montana

Director: B. W. O'Gara

Mule deer (Odocoileus hemionus) population ecology, movement patterns, and habitat use and selection were investigated in an area of the upper Missouri River breaks that would be potentially impacted by a proposed hydroelectric dam at Carter Ferry, Montana. Movement patterns and daytime habitat selection by mule deer were investigated using radio-telemetry and sign transects. Use of cropland by deer was also investigated using deer sightings, telemetry, and track transects. Home ranges were intermediate in size between those located in mountain-foothill and rolling prairie habitats, indicating moderate habitat complexity. Home range size was negatively correlated with doe age and the roughness of the area they occupied. There was a positive relationship between doe age and core area roughness, indicating possible differential mortality rates related to the roughness of the terrain. Over 90% of all daytime locations of instrumented deer and deer sign was located in rough breaks habitat. Deer avoided gentle upland and river bench habitats, and selected mesic sites including steep north slopes, shrubby coulee bottoms, and flood plain riparian areas.

Mule deer fed in grainfields from September to April if they were available. Deer used grainfields primarily at night, fed more often in stubble strips than new winter wheat, and preferred field areas <200 m from escape terrain and avoided areas >400 m from it. High reproductive and fawn survival rates of local mule deer indicated the population was in excellent nutritional condition.

Different daytime and nighttime movements and habitat use associated with the use of open terrain has apparently evolved as an antipredator strategy that is reinforced by human disturbance and hunting pressure. If the implied relationship between rough terrain and prairie mule deer habitat quality observed during this study proves consistent in other prairie habitats, then the rougher areas probably serve as refugia. Management implications of this relationship are discussed. Daytime habitat selection measured in this study corresponded to the daytime security or thermal requirements of bedded deer, plus some limited foraging requirements. The selective importance of mesic sites within or adjacent to rough terrain suggests that any resource development that would decrease the availability of these habitats would adversely impact mule deer populations in this area.





Helicopter drive-netting resulted in the capture of 42 mule deer in non-timbered river breaks habitat. Radio collars and colored neckbands facilitated a study of potential impacts of a proposed hydroelectric dam in the upper Missouri River breaks.

Photo by Montana Power Company



Although bands of riparian vegetation served as important habitat for those mule deer whose home ranges included such habitat, the home ranges of most mule deer does on the study area occurred well above the proposed zone of inundation.

Photo by Susan Kraft Ball

ABSTRACT

Orthmeyer, Dennis L., Winter 1987

Wildlife Biology

Survival of Mallard Broods on Benton Lake National Wildlife Refuge,
North-central Montana (58 pp.)

Director: I. J. Ball

Duckling survival was measured in broods of 31 radio-marked hen mallards (*Anas platyrhynchos*) on Benton Lake National Wildlife Refuge in north-central Montana during 1985 and 1986. Radio-marked hens were located 1 to 7 times daily. Observations of marked and unmarked broods supplied data on duckling survival. Overall survival for the 60-day pre fledging period was 0.39, with 85% of the mortalities occurring within the first 18 days. Total brood loss occurred in 37% of all broods tracked, occurred within 24 days post-hatch, and accounted for 60% of all duckling losses. Broods that survived to fledging averaged 5.0 ducklings. Ducklings in broods that hatched early (before 10 June) had a 60-day survival probability of 0.44, significantly higher than in late broods (0.33). A significant correlation existed ($r = 0.46$, $P = 0.03$) between condition index of hens fledging broods and the number of ducklings they fledged. Condition index of hens declined as the season progressed. Mean brood size did not differ significantly between broods of radio-marked and unmarked hens.



ABSTRACT

Leary, Robb F., Ph.D., June 1985

Zoology

Genetic Control of Meristic Variation in Salmonid Fishes (67 pp.)

Director: F. W. Allendorf

The importance of understanding the genetic and developmental basis of morphological variation from an evolutionary perspective has been receiving increasing emphasis. The primary objective of this research was to begin to obtain an understanding of the genetic control of meristic variation in salmonid fishes from an evolutionary perspective.

The counts of seven out of eight meristic characters in a population of rainbow trout, Salmo gairdneri, have high "narrow sense" heritability estimates (0.37 to 0.93). Although the counts of these characters are polygenically controlled, genetic variation at a single regulatory locus, Pgml-t, that affects the expression of a phosphoglucosylase locus, Pgml, in the liver has major effects on the counts in this population. There is a significant difference between the multivariate distributions of the counts of these characters between full-sibs with and without liver Pgml expression in eight of nine families. This difference is due to the tendency for fish with liver Pgml expression to have lower counts. The magnitude of this morphological difference is comparable to that observed between two subspecies of cutthroat trout, Salmo clarki, that have substantial genetic divergence at 42 enzyme loci (Nei's $D = 0.340$). These data directly support the view that small changes in the developmental process due to genetic differences at regulatory loci can have large effects on morphology.

The association between heterozygosity at 42 enzyme loci and relative developmental stability, as measured by fluctuating asymmetry at five bilateral meristic characters, was examined in populations of rainbow, cutthroat, and brook trout, Salvelinus fontinalis. In 13 of the 14 samples (sign test; $P < 0.001$), there is a negative correlation between the proportion of heterozygous loci and asymmetric characters per individual. This negative correlation is significant ($P < 0.05$) in two populations of rainbow and cutthroat trout. Thus, individuals more heterozygous at protein loci in populations of salmonid fishes tend to have increased developmental stability. Furthermore, individuals with obvious morphological deformities have increased fluctuating asymmetry and there is little or no additive genetic variation affecting fluctuating asymmetry. Fluctuating asymmetry, therefore, appears to be negatively associated with fitness. The association between heterozygosity and asymmetry suggests that heterozygosity is positively associated with fitness in salmonid fishes.





Cooperative studies involving the Montana Unit and the Confederated Salish and Kootenai Tribes addressed the potential impacts of water level fluctuations, as influenced by hydroelectric dams, on Canada geese in the lower Flathead Valley. Virtually all nests on islands in lower Flathead Lake were above high-water mark, so direct impacts of water level fluctuations on nesting were nil. However, the current water regime on the lake creates a virtually barren zone between low- and high-water marks where vegetation cannot survive. This situation creates difficulties for broods in the spring because grazing areas can be separated from the security of open water by mud flats up to 1000 m wide.

Photo by BPA

Completion Report—Recovery of a Ground Squirrel Population
Following Applications of 1080 and
Effects of the Poisoning Program on Coyotes

B. W. O'Gara and T. Pate

Agricultural damage caused by Columbian ground squirrels (Spermophilus columbianus) resulted in renewed use of compound 1080 as a field rodenticide in several western Montana counties. Continued use of 1080 is probable unless an effective alternative control method is developed. This study was initiated in 1981 to evaluate the 1080 poisoning program. Major objectives were to: monitor the impact of the program on the most vulnerable nontarget species, establish guidelines for using 1080 effectively and economically, and develop criteria for determining when and where 1080 can be applied with satisfactory results and minimum hazards to nontarget wildlife populations.

The study was conducted during spring, summer, and autumn of 1981 and 1982 in the Blackfoot Valley of western Montana. The treatment study area was located on the Lindbergh Ranch and neighboring Lubrecht Forest, Greenough, Montana. The control study area was located on the Blackfoot-Clearwater Game Range.

Ground squirrels were live-trapped, marked, and released on treatment and control areas, as well as on unpoisoned areas surrounding poisoned fields. Pre- and post-treatment density estimates were derived using mark-recapture methods. Activity indices and burrow counts were used to judge the efficacy of 1080 treatments on certain areas. Litter sizes for ground squirrels representing both reduced and normal populations were determined by counting the number of embryos or placental scars found in squirrels collected in the field.

Coyote scat collection routes were established on the treatment and control sites to monitor coyote population fluctuations. Raven populations on the treatment area were monitored from May through August and poisoned areas were searched for carcasses after treatment.

Study results indicate that ground squirrels can be eliminated from areas for at least 2 years if 1080 is applied when squirrels are most active. The optimum times are just prior to parturition or after juveniles emerge from the burrows. However, optimum control is achieved only when an adequate buffer zone surrounding the target area also is poisoned. An area with a 230-m buffer zone would probably require treatments every 3 years to maintain a satisfactory level of control.

Ravens sustained the largest quantifiable loss among nontarget species as a result of the 1080 applications. Results of the coyote scat transects indicate that coyotes were not impacted by the treatment although population fluctuations were noted.

Rodents killed by haying machinery attract ravens and coyotes to hayfields. Therefore, it was recommended that 1080 not be applied during haying operations or for a period of at least 1 week thereafter. In addition, the 230-m buffer zone was found to be adequate for preventing significant recolonization of target areas.

Completion Report—Toxicity of Bromadiolone-poisoned Columbian
Ground Squirrels to Red-tailed Hawks and
Great Horned Owls

J. C. Malloy, B. W. O'Gara, and J. S. Dahlke

Bromadiolone is an anticoagulant rodenticide currently used against commensal rodents. Little is known about its toxicity to potential scavengers of field-poisoned rodents. This study was undertaken to determine the toxicity of Columbian ground squirrels (Spermophilus columbianus) fed bromadiolone-treated bait at 2 dosage levels (25 ppm and 50 ppm) to red-tailed hawks (Buteo jamaicensis) and great horned owls (Bubo virginianus).

In Experiment 1, 6 hawks and 6 owls were fed poisoned squirrel carcasses for 7 consecutive days. Three hawks and 3 owls received squirrels fed the 25 ppm bait, and 3 of each species were fed squirrels poisoned with the 50 ppm bait. None of the hawks in the 25 ppm group died, but one of the 3 in the 50 ppm group died during the 30-day post-treatment observation period. Two of the 3 owls in the 25 ppm group and all 3 of the owls in the 50 ppm group died.

In Experiment 2, 4 hawks and 4 owls were fed poisoned carcasses for either 3 or 4 days. Two hawks and 2 owls were fed squirrels from the 25 ppm groups, and 2 birds of each species were fed carcasses from the 50 ppm group. None of the hawks in either dosage group died, but 1 owl from the 25 ppm group died during the observation period, possibly from causes unrelated to the experiment.

Great horned owls appeared to be more susceptible to bromadiolone-poisoned squirrel carcasses than were red-tailed hawks. The 3- to 4-day exposure period represented a lower hazard to the owls than the 7-day exposure period.



Completion Report—Ecology of Wild Goats and Urial in Kirthar National Park, Pakistan

B. W. O'Gara, W. D. Edge, and S. L. Olson-Edge

A general ecology study of the wild goat (Capra aegagrus) and urial (Ovis orientalis) was conducted in Kirthar National Park, Pakistan, between January and October 1986. Thirty-four wild goats and 8 urial were captured and marked at a waterhole using a netgun and leg-hold snares. Morphological measurements and pelage characteristics were compared to those in the literature and the subspecies status of both species is questioned. Regression equations were developed for predicting the live weight of wild goats. The best predictor of live weight was chest circumference for females ($r^2 = 0.944$) and total horn length for males ($r^2 = 0.958$). During random and systematic surveys of the study area, wild goats were seen 5,351 times and urial 698 times in 283 and 124 groups, respectively. Twenty-nine marked wild goats and 7 urial were re-observed 190 and 41 times. Based upon mark-recapture methods, the density of wild goats ranged from 11.8 to 16.3/km². Urial densities were estimated to range from 1.7 to 2.5/km². The study area contained 2 female-young goat herds with little or no overlap in herd ranges, and 1 male herd that overlapped and mixed with both female-young herds. Only 1 herd of urial were believed to inhabit the study area. Sex ratios of yearling and adults significantly favored females for both species. Young goats were born from mid-January through mid-May, but urial were born during a 2-3 week period in early February. Throughout the field season, we observed 32.3 young goats and 38.8 young urial/100 adults, respectively. Adult females of both species were accompanied by either young of the year or yearlings, and we hypothesize that nutritional stress during successive years of drought resulted in an alternate year reproductive strategy. Both species rutted during a 2-3 week period starting 2 weeks after heavy rains in mid-August. We hypothesize that nutritional stresses during drought years resulted in an asynchronous estrus in wild goats. The population age structure of wild goats was evenly distributed among all age classes with the exception of 5- and 6-year old females which were more abundant. We believe the wild goat population to be stable or slowly increasing and regulated by forage quality, which varies considerably due to fluctuations in annual precipitation. The urial population was composed primarily of adults, but was believed to be increasing slowly. The urial population appears to be regulated by the same mechanism as the wild goat population with additional effects from poaching and competition from domestic livestock, because of the urial's preference for lower, gentler slopes. Group sizes for both species varied by group type and season. In general, group sizes appeared to be related to the availability and quality of forage, being smallest during the hot season and largest during the monsoon or rutting season. The only stable associations for both species were between adult females and their young or yearling offspring. Wild goats during the rutting season predominantly used moderately steep (31-60 degrees), mid- to upper slopes between 300 and 600 m in elevation. Traditional bedding sites were used at night. Habitat preferences of the 2 species make the wild goat less susceptible than urial to the effects of human encroachment.

Completion Report—The History, Ecology, and Management of the Rocky Mountain Population of Trumpeter Swans

R. S. Gale, E. O. Garton, and I. J. Ball

Trumpeter swans have been the object of intensive management and research since the 1920's when efforts began to restore the species from near extinction. Although management efforts successfully increased the number of trumpeters in the Rocky Mountain Population (RMP), the recovery is still precarious. Despite their increasing numbers and summer distribution, all known Canadian and U.S. breeding flocks share common wintering sites in the Tristate area of Wyoming, Montana, and Idaho. A disease outbreak, habitat depletion, or exceptionally severe winter weather and ice conditions could impact the entire population. Since the 1950's, the breeding swans of the Tristate area have experienced low cygnet production, high over-winter losses, and a decline in total numbers. These trends accelerated in the 1980's as the adult component of the Tristate subpopulation declined by 28% from 1980 to 1986. The number of nesting pairs declined by about 50% at Red Rock Lakes NWR and Yellowstone National Park, and the rate of cygnet production continued to decline.

Most of the existing information on RMP trumpeters was assembled and synthesized. This effort involved the U.S. Fish and Wildlife Service, the Canadian Wildlife Service, Idaho Department of Fish and Game, Wyoming Game and Fish Department, and Montana Department of Fish, Wildlife and Parks, and the Trumpeter Swan Society. The core of the analysis focused on the 52-year data base assembled from the files of Red Rock Lakes NWR. The final report provides a detailed case study of 60 years of management of an endangered species, including chapters on: distribution and abundance, population trends, nesting and cygnet production, reproductive behavior, mortality, summer habitat, aquatic vegetation at Red Rock Lakes NWR, winter distribution and habitats, movements of marked birds, bioenergetics and food habits, genetic considerations, population-habitat relationships, and management recommendations.

The problems faced by the Rocky Mountain Population today originate from events that occurred in the 19th century. Outside of Alaska, the species was reduced to approximately 150 adults that wintered in remote geothermal sites in the Tristate region. As the species was destroyed, the cumulative knowledge of traditional migration routes to other less harsh winter and spring habitats was also destroyed. The few survivors wintered in one of the most severe wintering sites in North America, an area where both dependable ice-free water and security from human persecution could be found. Although the descendants of this remnant have increased in number, the population's knowledge of other historic wintering sites has not been restored, and virtually all RMP trumpeters now return each winter to the Tristate region. Increasing numbers of trumpeters are dependent upon this harsh winter environment. As a result, their winter survival and productivity is strongly influenced by various natural factors and management actions that affect the availability and quality of winter and spring habitats. The decline in the Tristate subpopulation was due to a combination of factors including a cycle of harsh winters and cold, wet springs; reductions in the winter feeding program at Red Rock Lakes NWR; fluctuating water releases in the Henry's Fork River; nest flooding at Red Rock Lakes NWR; removals from

the Centennial Valley flock; and increased human disturbance at nesting territories. In addition, lead poisoning caused increased mortality: 11 of 34 swans necropsied between 1980 and 1986 died from lead poisoning. The swans' overall viability may also have been reduced due to the loss of heterozygosity during the bottleneck of the late 1800's and subsequent genetic drift.

Because the population remains dependent upon one very harsh winter range, its future is precarious. Increasing numbers of wintering swans may have the capacity to deplete the aquatic vegetation at several wintering sites. Many birds are severely stressed and emaciated by winter's end. Because all the known flocks share a common winter range, the entire population is vulnerable to a disease outbreak or the effects of a severe winter with extensive ice formation.

The migratory Canadian trumpeters are highly vulnerable to severe winter weather in the Tristate area. As they slowly migrate north during March and April, however, they apparently gain the nutrient reserves required for successful production. Although their annual productivity is also reduced by adverse spring weather, the Canadian migrants surpass the nonmigratory Tristate trumpeter in all measures of reproductive success. Without the traditional knowledge of more southerly winter and spring habitats, the nonmigratory Tristate trumpeters are dependent exclusively on harsh, high elevation winter and spring habitats. During most years, many pairs appear unable to obtain the nutritional reserves needed to provision a normal clutch and to produce viable cygnets. Most of the Tristate subpopulation depend upon the supplemental winter feeding at Red Rock Lakes NWR to survive the winter. Their reproductive success is strongly influenced by the highly variable spring habitat conditions. The Tristate trumpeters will remain dependent upon supplemental feeding and extremely vulnerable to fluctuating spring weather and habitat conditions as long as they remain nonmigratory. Managers must take action to create other winter and spring habitats and rebuild broken migratory traditions to restore a healthy Rocky Mountain Population of trumpeter swans.



Completion Report---Analysis and Modeling of Grizzly Bear
Population Trends

Subproject 1: STOCHASTIC INFLUENCES ON SUSTAINED YIELDS OF
GRIZZLY BEAR POPULATIONS

Richard B. Harris and Lee H. Metzgar

We examined sustainable yields of grizzly bear populations subject to different levels of demographic and environmental stochasticity using a stochastic simulation model incorporating non-linear density dependence.

In all cases, the probability of decline increased sigmoidally from near 0 to 1 as harvest levels increased.

Sustained yields, expressed as a proportion of population size, were higher for larger populations and lower for smaller populations, suggesting that chance demographic events played a significant role in declines of small populations.

Minor environmental fluctuations also reduced sustainable yields, but, as modeled, were generally less important than chance age-structure changes.

Subproject 2: ESTIMATING HARVEST RATES OF BEARS FROM SEX RATIO CHANGES

Richard B. Harris and Lee H. Metzgar

Using simulation modeling, we assessed the potential for estimating harvest rates for bear (Ursus spp.) populations from changes in kill sample sex ratios (Palcheimo and Fraser 1981, Fraser 1984). Models underlying these techniques require assumptions that may be violated in the field. We found that both estimators were sensitive to violations of 4 critical assumptions, and that bias was generally most pronounced when applied to bear populations with low harvest rates, moderate differences in hunting vulnerability between sexes, and complex age structures. Additionally, bears typically occur in low densities and yield small harvests, producing limited data from which harvest estimates are produced. Chance deviations from the expected patterns occurred with small (20-180) samples of harvested bears, producing substantial variability in year-to-year estimates.

Subproject 3: GAPPS (Generalized Animal Population Project System)

Richard B. Harris, Lee H. Metzgar, and Collin D. Bevins

This micro-computer-based, stochastic population simulation language, now available, may be a useful tool for biologists, wildlife managers, biometricians, students, etc., who have a specific need for a stochastic population projection model but lack advanced computer programming skill. Individual animals are treated, and the program allows a wide range of options, such as immigration, hunting, density-dependent effects, and inbreeding. A thorough User's Manual accompanies the diskette. GAPPSS operates on IBM PC/AT compatible machines with 640K memory and an 8087/80287/80387 math co-processor. User's are expected to have rudimentary skills in using a screen editor, and the program also requires an MS-DOS/PC-DOS 2+. type operating system, and either dBASEIII

or dBASE III+ (registered trademarks of Ashton-Tate, Inc.). Please specify version GAPPS 3.0 for use with dBASEII, or GAPPS 3.1 for use with dBASE III+.



Sustainable yields of grizzly bear populations subjected to different levels of demographic and environmental stochasticity were examined using a stochastic simulation model incorporating non-linear density dependence. Sustained yields, expressed as a proportion of population size, were higher for larger populations and lower for smaller populations, suggesting that chance demographic events played a significant role in declines of small populations.

Photo by Joe Perry

Completion Report—Grizzly Bear Habitat Use, South Fork
of the Flathead River, Montana

L. Jack Lyon, D. A. Hadden, H. Carriles, and
L. Klassen

Grizzly bear radio location points are used to evaluate a habitat classification based on plant community types (c.t.). The assumptions of analysis are that grizzly bears select the c.t. or combination of c.t.'s best suited to satisfying daily requirements from among those readily available, and that habitat selection changes seasonally as requirements change.

Data describing plant community types are presented. Discriminant function analysis is used to identify c.t.'s important during two seasonal periods (pre-berry and berry), and, using these c.t.'s, to correctly classify habitat selection. Habitat use by individual bears is compared with use by all bears combined. Minimum correct classification for individual bears in the pre-berry season is 78.6 percent, and for bears combined is 67.8 percent. Maximum classification for individual bears in the berry season is 100.0 percent, and for bears combined is 90.5 percent.

In separate tests, Spearman's rank correlation was used to test the functional relationships between c.t. importance values (CTIV) and the frequency of bear use of discrete c.t.'s, and of mean areas of c.t.'s found within 100-acre scan circles, for the pre-berry season. These results are shown to be related to known physiological and behavioral requirements of grizzly bears.



RESEARCH PROJECTS

Physiologic and Ecologic Studies of the Pronghorn (Antilocapra americana)

Project Leader: B. W. O'Gara

Cooperators: National Bison Range, U.S. Fish and Wildlife Service; Montana Department of Fish, Wildlife and Parks; and the Wildlife Management Institute

Objectives:

To study:

1. the reproductive physiology of male and female pronghorn;
2. the physiology and function of scent glands;
3. food habits related to changes in range conditions;
4. horn growth and casting; and
5. the relationships of pronghorns to other artiodactyls.

Results:

Ten chapters for the Wildlife Management Institute pronghorn book have been sent to editor, and one was submitted for a book on horn morphology and social behavior.

Duck Banding in Canada

Project Leader: I. J. Ball

Student Technicians: Varies, 4 to 6 annually

Objectives:

1. Trap and band 2000 mallards and up to 1500 pintails and 1000 of each of the other species available. This quota will be sought at each of 10 banding stations.
2. Maintain accurate records and provide summary reports from each station to the Migratory Bird Management Office.
3. Provide students from the Montana Cooperative Wildlife Research Unit with training in waterfowl research techniques and an ecological perspective that can only be obtained through on-the-ground experience.

Results:

Vary annually. Detailed annual reports are available.

Beaver Populations on Impounded and Unimpounded Rivers:
Densities, Habitat Profiles, and Mitigation Strategies

Project Leader: B. W. O'Gara

Student Investigator: R. Bown

Cooperator: Montana Power Company

Objectives:

1. Determine beaver population levels and patterns of habitat use on the Carter Ferry study area.
2. Compare population densities on impounded and unimpounded river segments.
3. Develop a "profile" of occupied habitat along impounded and unimpounded river segments.
4. Predict the effects of anticipated water levels on the availability of potential beaver habitat after completion of the Carter Ferry Dam and identify possible mitigation measures.

Results:

Student investigator is working for the Forest Service and is in final stages of thesis writing.



Nest Success of Upland-Nesting Ducks
in the Flathead Valley, Montana

Project Leader: I. J. Ball
Technician: N. Hall
Cooperators: USFWS, National Bison Range; Montana
Department of Fish, Wildlife and Parks

Objectives:

1. Document nest success of upland-nesting ducks on refuge and WPA lands in the Flathead Valley.
2. Compare nest success among species and cover types.
3. Identify general causes of nest failure and predator species where possible.
4. Provide experience for undergraduate wildlife students in gathering and interpreting duck nest success data.

Results:

Baseline data collected in 1986 and 1987 suggest that nest predation is a serious problem for ducks in the Flathead Valley. Mayfield nest success in ducks has averaged about 20%, and nest densities are low (140 nests found on 2040 acres in 1987). Predation was responsible for nearly all nest failure. Plans for 1988 are to conduct and evaluate the effects of skunk removal on selected tracts.

Pheasant Nesting Success in the
Flathead Valley, Montana

Project Leaders: I. J. Ball and B. W. O'Gara
Student Investigator: K. Tsai
Cooperators: Montana Department of Fish, Wildlife and
Parks; Bureau of Indian Affairs,
Confederated Salish and Kootenai Tribes;
USFWS, National Bison Range

Objectives:

1. Determine nesting success.
2. Determine the impact of skunk removal on nesting success.
3. Identify cover types in which hatching success is highest.
4. Submit management recommendations.

Results:

Field work was initiated on 3 May 1987 and continued through early July 1987. Nest success and habitat characteristics were recorded for a sample of 29 nests. Preliminary data analysis and report are underway. The second field season will begin in May 1988.

An Evaluation of Elk-Livestock Interactions
in Central Idaho

Project Leader: B. W. O'Gara

Student Investigator: S. P. Kratville

Cooperators: Idaho Department of Fish and Game; U.S.
Forest Service; Bureau of Land Management

Objectives:

1. Document movements of radio-marked elk in relation to cattle distribution on spring, summer, and fall ranges.
2. Determine habitat use by radio-marked elk in relation to cattle distribution on spring, summer, and fall ranges.
3. Compare the nutritional well-being of elk subjected to livestock disturbance with that of undisturbed elk (DAPA method).
4. Develop year-round DAPA profiles for the wintering elk herd at Willow Creek Summit.

Results:

More than 900 radiolocations have been made and DAPA analysis is complete. The student investigator has completed required coursework and will analyze data and write her thesis during fall and winter 1987-88. She has permanent employment with the U.S. Forest Service, but will get educational leave to complete her project.



The Yaak Moose: Habitat Relationships
and Population Status

Project Leader: L. Metzgar
Student Investigator: B. Costain
Cooperators: Montana Department of Fish, Wildlife and
Parks; Louisiana Pacific Corporation; J. E.
Davis; Kootenai National Forest

Objectives:

1. Document habitat selection by moose in the Yaak River drainage and identify habitat components of significance.
2. Delineate seasonal movements and home ranges.
3. Estimate population densities and productivity.
4. Assess the impact of human activities—logging and hunting in particular—on these first three groups of parameters.
5. Develop guidelines that integrate timber stand manipulation with moose habitat management, and suggest ways of monitoring population trends.

Results:

Fieldwork is completed and the student should complete his thesis soon.

River Otter Population Status and Habitat
Selection in Northwestern Montana

Project Leader: L. Metzgar
Student Investigator: A. E. Dronkert
Cooperators: Montana Department of Fish, Wildlife and
Parks

Objectives:

1. Document the distribution of river otters on northwest Montana waterways.
2. Identify and map habitat for otters on northwest Montana waterways.
3. Quantify habitats used by otters in the Flathead River basin.
4. Determine otter population size in the Flathead River basin.
5. Model the effects of harvest on river otters in northwest Montana.

Results:

Five river otters were captured in the Flathead River Valley and implanted with radio transmitters and radioisotope markers during fall 1986, and 259 radiolocations were obtained. These will be used to determine habitat use, movements, and home ranges. Forty latrine sites were surveyed and quantified once each during spring. Scats (361) are currently being analyzed for radioisotope tracers and prey remains. Data analysis will continue through September 1987 and a final report is expected in January 1988.

India Mountain Project

Project Leader: B. W. O'Gara
Field Biologists: J. Fox, S. P. Sinba, R. Singh, and P. Das
Wildlife Officers: N. Ahmad, C. Rigpin, M. Raza
Logistics Consultant: A. Chondola
Cooperators: Wildlife Institute of India; International Snow Leopard Trust

Results:

A representative biogeographic cross-section of snow leopard habitat in northwestern India was surveyed during a 9-month period to determine relative presence of the snow leopard and its prey and to assess the degree and impact of human interaction with these species. The surveys were conducted predominantly at elevations between 3000 and 4500 m, and included approximately 1100 km along major and minor valley routes, plus another 850 km of side-slope surveys and foot travel to access survey sites. Snow leopard sign was found to be most abundant in central Ladakh (Jammu and Kashmir), less so in southern Ladakh, and least abundant on the southern side of the Himalaya in northern Uttar Pradesh and the Pir Punjal Range in Himachal Pradesh. The relative distribution and status of the snow leopard as compared with the common leopard needs to be more fully investigated in these latter two areas. More than 100 km of individual snow leopard tracks were followed in Ladakh, yielding substantial data on movements and habitat use. Snow leopards were found to use habitats closely associated with sharp breaks in terrain such as cliffs and river bluffs. Two observations of snow leopards near villages and numerous interviews with local people produced insight into both negative and positive interactions between man and wildlife in the high altitude region of snow leopard habitat.

More than 500 ibex were observed during the surveys in southern Ladakh and northern Himachal Pradesh, and about 750 blue sheep were counted in all survey areas, mostly in the region of central Ladakh. Other large mammals observed included the Tibetan argali, Ladakh urial, Himalayan tahr, brown bear, and wolf. Some areas appear to have healthy populations of ungulate prey species, whereas others are being degraded by excessive hunting and competition with livestock. It is clear, however, that if adequate and consistent efforts are made to manage wildlife and habitat in Ladakh, there should be sufficient resources for a viable population of snow leopards.

Surveys were conducted in proposed or existing national parks and wildlife sanctuaries, thus making the results applicable in formulating recommendations for conservation site location and management in these areas. For example, the current consideration given by the Government of Jammu and Kashmir toward extending the boundaries of the Hemis High Altitude National Park southward to include the Khurnak catchment as a core area (as recommended in this report) should be instrumental in providing the basis for protection of a good population of snow leopards. Continuation of high altitude ecological studies stressing the comprehensive examination of snow leopard ecology and wildlife-man interrelationships in snow leopard habitat of central Ladakh is recommended for initiation by the Wildlife Institute of India in 1987.

Wildlife Conservation and Management Training
Program, Peshawar, Pakistan

Project Leader:	B. W. O'Gara
Personnel:	L. Metzgar and R. Greene
Cooperators:	Pakistan Forest Institute; Zoological Survey of Pakistan; U.S. Fish and Wildlife Service, Office of International Affairs; Department of Forestry, Baluchistan

Results:

Another school is anticipated in 1988, but plans are not finalized.



Ecology of Bald Eagles Wintering Along the
Columbia River in South-Central Washington

Project Leaders: I. J. Ball and B. R. McClelland

Student Investigator: S. A. Eisner

Cooperators: Northwest College and University
Association for Science; U.S. Department of
Energy; and Battelle, Pacific Northwest
Labs

Objectives:

1. Determine the combination of environmental factors that best explains bald eagle distribution along a 136-km stretch of the Columbia River between the Tri-Cities and Wanapum Dam. Compare diurnal and nocturnal distribution on the Hanford portion of this stretch.
2. Summarize perch use over the entire study area and for perch trees on the Hanford Reach, characterize individual trees and tree clumps used for diurnal and nocturnal perches and compare with trees not used.
3. Describe and quantify communal night roost behavior.

Results:

Bald eagles were observed during 2 winter field seasons, January through Marcy of 1986 and October 1986 through April 1987. All field work has been completed and data analysis is now in progress.

Twenty-five aerial surveys with 655 bald eagle sightings were made during the winter of 1986-87 to examine eagle distribution in conjunction with environmental factors, including perch sites, prey, and human activity. Bald eagles were also surveyed in 3 major and 8 minor communal night roosts on the Hanford Site the evening before and after aerial surveys to compare roost use with diurnal distribution.

Bald eagle perch use was identified from 39 aerial surveys. Used and non-used perch trees within 300 m of the Columbia River shoreline on the Hanford Site were measured for height and diameter at breast height (dbh), and density, distances to the river, nearest structure, and distances from roads were determined.

Fifty-eight evening observation sessions were conducted at the 3 major communal night roosts. All activities were quantified for each of 418 bald eagles during 142 hours of observation.

Establishment, Funding, and Execution of a
Sister Institution Agreement Between
The Northwest Plateau Institute and
University of Montana

Project Leaders: B. W. O'Gara, R. C. Murray, and D. M. Murphy

Student Investigators: To be assigned

Cooperator: Michael Murphy Foundation

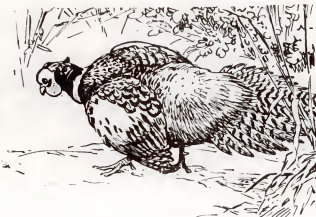
Objectives:

To negotiate and execute a sister institution agreement that will:

1. provide research opportunities in Qinghai Province, China, for U of M Ph.D. candidates;
2. provide research and training opportunities for Chinese students at U of M to facilitate better wildlife management in Qinghai Province;
3. broaden the scope of experience of U of M graduate students and professors and of NWPI graduate students and professors; and
4. directly aid Chinese biologists in planning, research, and management regarding wildlife resources in western China.

Results:

A concise but comprehensive Sister Institution agreement was negotiated between NWPI and U of M during summer 1987. The agreement was signed by O'Gara, acting for U of M President Koch, and by Wang Zuwang, Director of the NWPI. Both institutions are recruiting Ph.D. candidates to exchange by autumn 1988.



Nesting Structures for Mallards and Canada Geese: a Handbook

Project Leader: I. J. Ball
Research Assistant S. K. Ball
Research Cooperator: F. B. Lee
Cooperators: USFWS: Division of Refuges, Region 6,
Region 4, and CUC Extension

Objective:

Produce a practical handbook on the use of waterfowl nesting structures that will allow managers to make informed decisions about structure design and placement that will maximize effectiveness, durability, aesthetic appeal, and nest security, and minimize construction and maintenance costs.

Results:

Assembly and review of literature is complete. Responses have been received from nearly 200 field personnel, and a summary of these responses is underway. Handbook completion is expected in 1987.

River Otter Habitat Use in Northwest Montana

Project Leaders: D. Pletscher and L. Metzgar
Student Investigator: A. Johnston
Cooperator: Montana Department of Fish, Wildlife & Parks

Objectives:

1. Compare habitat use of radio-implanted river otters to habitat use as determined from scat surveys.
2. Refine survey techniques to document the distribution of river otters in northwest Montana.

Results:

An inventory of river otter defecation sites is being conducted along the banks of the Flathead River from the north shore of Flathead Lake up to Columbia Falls. Radio-locations are being obtained for three implanted otters. Live-trapping will begin in September; captured otters will be implanted with transmitters and cryo-branded. Aquatic and riparian habitat measurements will be taken at use and availability transects. Latrine sites will be monitored and scat samples collected for analysis.

Beaver Dispersal in Northwestern Montana

Project Leaders: L. Metzgar and D. Pletscher

Student Investigator: M. Jackson

Cooperator: Montana Department of Fish, Wildlife & Parks

Objectives:

1. Quantify survivorship of dispersers and direction and distance of beaver dispersal in selected drainages in northwestern Montana.
2. Survey selected drainages to delineate experimental areas and determine the availability of habitat for dispersing beavers.
3. Gather supplemental data on age, sex, and productivity of beaver populations within the selected study areas.

Results:

Fieldwork begun in July 1987 has resulted in the selection of four drainages in northwestern Montana that represent both primary and secondary habitat for beaver. Survey work continues to determine appropriate experimental areas. Access to drainage areas on private land is currently being sought.

Live-trapping is scheduled to begin by mid-August. Live-trapped beaver will be tagged, weighed, separated into age classes, and sex will be recorded before release. Yearling beaver will be fitted with radio transmitters. Field work will continue until freeze-up, although transmitter-equipped beaver will be monitored periodically through winter. Field work will continue in the spring as soon as weather conditions allow live-trapping.

Canada Goose Nesting and Broodrearing in Relation
to Water Levels in the Flathead Valley

Project Leaders: I. J. Ball and J. J. Claar

Cooperators: Confederated Salish and Kootenai Tribes,
Bureau of Indian Affairs, Bonneville Power
Administration

Project Biologists: D. Mackey, S. Gregory, and B. Matthews

Tribal Technicians: K. Clairmont and B. Swaney

Objectives:

1. Document goose production on lower Flathead Lake and River.
2. Determine population impacts of providing additional secure nest sites for geese along the River.
3. Develop techniques and guidelines that maximize effectiveness of nest structure management programs, while minimizing costs. Experiment with nest materials to minimize deterioration and loss. Target: \geq 5-year intervals between maintenance visits.
4. Analyze physical and vegetation characteristics of nest sites.
5. Describe habitat selection by goose broods and relate it to water fluctuations on the study area.
6. Document the location of key goose brood rearing areas.
7. Describe the physical and vegetation characteristics of brood rearing areas.
8. Identify potential brooding areas that could be managed to maintain and improve brood habitat.
9. Record river water levels at key brood rearing areas when broods are present and relate these levels to releases from Kerr Dam.
10. Formulate any management recommendations necessary to protect and enhance brood habitat.
11. Document historical trends in availability of brood habitats.

Results:

Final report is complete. One scientific paper has been submitted for publication and several others are in draft form.



Black Bear Ecology and Observability Rates
In the Yaak River Drainage, Montana

Project Leader: B. W. O'Gara
Student Investigator: T. J. Thier
Cooperators: Montana Department of Fish, Wildlife, and
Parks; J. E. Davis; Kootenai National
Forest

Objectives:

1. Determine home range sizes and seasonal movements of adult bears.
2. Determine daily and seasonal activity patterns of adult bears.
3. Determine the observability rate of each sex and age group and compare with hunter-induced mortality.
4. Determine bear densities within the study area.

Results:

During 1986, 23 black bears were captured a total of 29 times. Sixteen of the 23 bears were captured during the spring trapping effort and 7 during the fall. Nine of the adult bears captured (5 males and 4 females) were fitted with motion-sensitive transmitters. All bears were tagged and marked with high-visibility ear streamers. Thirteen of the 23 bears captured were adult males. Other studies have indicated that a high proportion of adult males in a capture sample is indicative of an unexploited population.

Two marked black bears were shot by hunters during the fall hunting season of 1986, and 8 more were shot during the spring hunting season of 1987. Combined, the loss of 10 marked bears from the capture sample represents a mortality rate of 45%. Five of the 10 bears killed were instrumented.

Trapping was continued during May and June of 1987 to replace the collars from hunter-killed bears. Only 6 black bears were captured, 2 of which had been previously marked. Four of the 6 bears captured were instrumented. Currently, 3 adult females and 4 males are instrumented on the study area. In addition to the black bear captures, 5 grizzly bears have been captured a total of 11 times. They are being monitored by Wayne Kasworm of the Cabinet Bear Study.

Because of the high level of mortality on marked bears, plans to document observability rates for the different sex and age groups were halted. Instead, efforts to document activity patterns were intensified. From the data gathered thus far, it appears activity patterns are primarily crepuscular, with little or no movement occurring at night. Daytime activity levels increased with the onset of the berry season. Information on activity patterns for the fall period is not yet available.

Home range sizes for specific bears have not yet been calculated, but it appears adult males have a home range size

approximately double that of adult females. In 1986, 2 bears (1 male, 1 female) made extensive excursions to Idaho in July for 3-week periods, apparently in search of berries. Similar movements have not been observed for 1987, which may be a reflection of the better huckleberry (*Vaccinium* spp.) crop. However, an adult male, that had been tagged but not instrumented in 1986, was shot south of the Kootenai River during the spring hunting season. The distance from point of capture to where it was shot is approximately 24 miles (38 km). Instrumented bears appear to exhibit a high degree of fidelity to the 83 mi.² (133 km²) study area. All 8 instrumented study animals denned on the study area during the winter of 1986-87. Few locations are obtained on bears outside the study area boundaries.

Planned activities include the continued monitoring of instrumented bears, both for activity and locations, until they den this fall. Final completion of the thesis is expected in April of 1988.

Effects of Motorized Road Use on Grizzly Bear
Behavior, Habitat Use, and Reproductive Success

Project Leader:	B. W. O'Gara
Technicians:	B. N. McLellan
Cooperators:	U.S. Fish and Wildlife Service, Region 6, Grizzly Bear Recovery Coordination Office
Objective:	Assess effects of road use on grizzly bears. Describe activity patterns of grizzly bears.

Results:

The study of the effects of roads on grizzly bear behavior continued in 1987. The study area is on the Canadian side of the U.S./Canada Border, northwest of Glacier National Park. During the 1987 field season, investigators captured grizzly bears 9 times, replacing 3 old radio collars and fitting new collars to 4 previously uncaptured bears. Bears were located from aircraft 8 times during the summer. These locations were supplemented with ground locations. A student investigator used activity recorders to monitor signals and record the activity patterns of the collared grizzlies. Manuscripts titled "The Impact of Roads on the Behavior and Habitat Use of Grizzly Bears," "Dynamics of a Grizzly Bear Population During a Period of Resource Extraction," and "A Comparison between Grizzly Bear Harvest Data from Montana and Southeastern British Columbia" were submitted to the Journal of Wildlife Management, Ecology, and the Wildlife Society Bulletin, respectively.

Pronghorn Antelope Behavior in Northwestern
Nevada-Southwestern Oregon

Project Leader: B. W. O'Gara
Student Investigator: J. O. Meeker
Cooperators: Sheldon-Hart National Wildlife Refuge,
Double Four Corporation, NRA

Objectives:

1. Determine seasonal movements of pronghorns that summer on Hart Mountain and Sheldon refuges.
2. Determine breeding strategies used by pronghorn with home ranges in different habitat types.
3. Determine selected trace element content of vital organs and hair of pronghorn taken at Hart Mountain and Sheldon refuges.
4. Compare Hart-Sheldon trace element data with hair taken from Idaho and Montana pronghorns.

Results:

The shortage of usable information precluded the writing of a dissertation, as was initially planned. At the suggestion of the project leader, the student investigator is presently working on a less comprehensive completion report.

Kerr Dam Wildlife Studies

Project Leaders: J. J. Claar and I. J. Ball
Project Biologists: D. Becker, C. Mack, P. Mullen, K. Murphy,
and A. Soukkala
Cooperators: U.S. Bureau of Indian Affairs, Confederated
Salish and Kootenai Tribes

Objectives:

1. Determine the effects of the Kerr Project on bald eagles and ospreys
 - a. hunting success,
 - b. feeding site selection,
 - c. food habits, and
 - d. reproduction.
2. Document distribution of furbearer species along the river and lake.
3. Correlate furbearer distribution with riparian vegetation types and other factors.
4. Estimate relative abundance of furbearer species.

5. Determine effects of water level fluctuations on furbearers and habitat.
6. Formulate management and mitigation recommendations necessary to protect and enhance riparian habitat and furbearer population levels.

Results:

Aerial surveys were conducted from October through March to determine population trends of wintering bald eagles on the Flathead Indian Reservation. Habitat use and prey availability were also summarized during these surveys. Wintering bald eagle numbers peaked at 70 during mid-January. Observations of wintering birds during the period provided information on foraging success and prey utilization at various water levels on Flathead Lake and the Lower Flathead River.

Fieldwork from March through September provided additional documentation of breeding chronology and reproductive ecology of bald eagles and ospreys. Six occupied bald eagle nests were located. These produced a mean 2.0 fledglings per occupied nest and per successful nest. Osprey nests on the study area produced 1.3 fledglings per occupied and 1.9 per successful nest. Observations throughout the period provided data on foraging movements, foraging success, and food habits. These data will be correlated with water-level data to determine the effects of changing water-levels on both species.

Radiotelemetry techniques were employed to monitor movements, den use, and activity patterns of 6 beaver on the Lower Flathead River. Collected information will be correlated with discharge rates from Kerr Dam to evaluate the effects of changing water levels on the Lower Flathead River beaver population.

Research on evaluating the effects of winter drawdown of Flathead Lake on muskrat populations continued. Population estimates for fall and following spring periods indicated a marked population decline during winter and early spring months. Fates of radio-marked muskrats also supported a hypothesis of high over-winter mortality rates caused by winter drawdown of Flathead Lake.

Distribution, Ecology, and Management of
Wolves in Northwest Montana

Project Leader: R. R. Ream

Technicians: M. Fairchild and D. Boyd

Cooperators: U.S. Fish and Wildlife Service; Montana
Department of Fish, Wildlife and Parks

Objectives:

1. Describe the distribution and status of wolves in northwestern Montana.

2. Determine food habits and movements of wolves in a colonizing wolf population.
3. Determine what factors may be limiting wolf recovery in northwest Montana.
4. Provide management recommendations for the recovery of wolves and resolution of wolf-human conflicts.

Results:

The wolf monitoring and research effort conducted in the North Fork area during the past 3 years has documented substantial changes in the wolf population. When the first wolf (W8401) was radio-collared in 1984, he and the 6 nonradio-collared members of the Magic Pack were the only wolves present in the area. In 1985, W8550 had a litter of 7 pups just north of Glacier National Park (GNP), and in 1986 she had the first litter (5 pups) in GNP in some 50 years. Now, in mid-1987, we have 8 radio-collared wolves, 3 successful dens, at least 15 new pups, and a population of perhaps 30 wolves.

During the past year we have witnessed splitting of the Magic Pack into 2 packs, the Camas Pack and Sage Creek Pack, and formation of the new Wigwam Pack by formerly lone male W8401. Although the recovery plan goal is 10 breeding pairs, and there are 3 breeding pairs in the study area, only 1 of those breeding pairs is in the United States, the other 2 in British Columbia. During the past year we have also witnessed a major long-range dispersal by female W8551 890 miles to the north to the Peace River area near the British Columbia/Alberta border. If she had moved south instead, she would have been well past Yellowstone National Park in the Rocky Mountains. Although all other radio-collared wolves are accounted for, we may have had additional non-radioed wolves disperse from the study area that we were not able to document. This emphasizes the need to document dispersal.

In March 1986, 4 wolves apparently left the Magic Pack. Shortly thereafter, project and GNP personnel found tracks of 4-5 wolves in the St. Mary area on the east side of GNP. It was easy to speculate that the wolves on the east side originated from the wolves that left the Magic Pack. However, in the wolf control actions that occurred approximately 15 km east of St. Mary in summer 1987, it was learned that all but 1 adult was gray, whereas all 4 that left the Magic Pack were black. The black 3-legged wolf that was taken had been seen and photographed in GNP the previous winter.

The wolves appear healthy, there is rapid growth in the young, and they attain large size and weight. We feel that natural mortality will be very low in the near future. The major source of wolf mortality will probably continue to be human-induced. If a major portion of the wolf population continues to use GNP, human-caused mortality will be minimized, because there is no legal hunting or trapping in the Park. British Columbia initiated its first hunting and trapping season for wolves in the North Fork in 1987. With 2 packs, containing 6 radio-collared adults, residing there, the Wolf Ecology Project (WEP) personnel will be able to document wolf mortality that might occur.

A substantial shift in home range of the Magic Pack occurred in

CONSERVATION, EDUCATION, AND PUBLIC RELATIONS

Bart O'Gara, Unit Leader

- 6-8 October Attended a Boone and Crockett Club meeting at UM regarding the Theodore Roosevelt Ranch.
- 6 October Lectured 3 hours on Montana carnivores to Montana wildlife class (45 nondegree students).
- 23 October Participated in a panel discussion on reintroduction of wolves to Yellowstone National Park at a Wildlife Federation meeting in Bozeman, Montana; approximately 80 people attended.
- 23 October Gave a slide presentation on Asian research and wildlife management at Montana State University, Bozeman; about 40 professors and wildlife students attended.
- 30 October Received a U.S. Department of Interior Meritorious Service Award from Dick Smith at a President's luncheon.
- 5 November Necropsied a pronghorn at the National Bison Range for a UM large mammal conservation class (35 undergraduate students).
- 12 November Gave a 3-hour lecture on large mammal capture and drugging to the large mammal conservation class (35 undergraduate students).
- 13 November Met with UM Vice President for Research, Dean of Arts and Sciences, and several Department Chairmen to draft a Sister Institution Agreement between the University of Montana and the Western Plateau Institute, Academia Sinica, China.
- 18 November Lectured to the Zoology areas and concepts class on the Unit program (9 graduate students).
- 1 December Lectured for 3 hours to wildlife ecology class at Salish and Kootenai Community College on ruminants of Montana.
- 9 December Attended an ADC meeting on rodent research, Bozeman, Montana.
- 10-12 December Refereed a 55-page manuscript for the Ontario Ministry of Natural Resources.
- 16 December Attended all-day meeting of Oversight Committee on Wolf Research.

- 17-18 December Attended a meeting and field trip sponsored by the Lolo National Forest on management of elk and skiers in the Rattlesnake drainage.
- 14 January Attended a meeting and field trip of the National Wildlife Federation Land Management Committee in Missoula and discussed problems related to winter ranges in the Grant Creek and Rattlesnake Creek drainages.
- 14 January Met with the President of the Friends of the Rattlesnake to discuss excluding skiers from elk winter range.
- 16 January Lectured on endangered species and cites to a UM EVST class (17 graduate students).
- 26 January Attended meeting to discuss progress and new studies needed in the Mission Oriented Research Program.
- 29 January Met with land developers and Missoula County Planners to draft a conservation easement that would benefit elk and mule deer.
- 4 February Presented a zoology seminar on wildlife and research in China (60 graduate students and professors).
- 4 February Discussed wilderness and the C. M. Russell NWR at a meeting in Missoula of the Wilderness Institute (approximately 100 students and general public).
- 9 February Brought 15 UM students and participated in trapping 30 bighorns near Anaconda, Montana, for transplants by the Montana Department of Fish, Wildlife and Parks.
- 10 February Collected four bison on the National Elk Refuge, Jackson Hole, Wyoming, to trade for yaks with China.
- 15 February Gave a slide program on Eurasian and African hunting/game management programs at an Institute of the Rockies meeting in Missoula (90 members were present).
- 16 February Served as a panel member to discuss trespass fees related to hunting at an Institute of the Rockies meeting (75 members attended).

- 21 February After-dinner speaker on worldwide hunting at the Central Montana Bow Hunters' banquet in Lewistown, Montana (250 attendees).
- 24 February Attended meeting of MSU and UM administrators and wildlife faculty in Bozeman to decide on joint programs.
- 26 February Brought 20 UM students to the National Bison Range and directed the trapping of 24 mountain goats for transplant by Montana Department of Fish, Wildlife and Parks personnel.
- 2-4 March Attended the Region Six Project Leaders' meetings at Denver Federal Center.
- 6 March Received 30-year Service Award from U.S. Fish and Wildlife Service.
- 9 March Presented a slide program on game management in third world countries, and ways to educate biologists, the public, and politicians in those countries, at a fund raiser for the International Film Festival in Missoula.
- 10 March Netgunned 6 pronghorn does for transfer to the National Bison Range.
- 10 March Presented a program on pronghorn biology, management, and hunting to the Prickly Pear Sportsmen's Club in East Helena (120 attendees).
- 11 March Necropsied pronghorn for large mammal conservation class on National Bison Range (35 undergraduate students).
- 12 March Met with Forest Service personnel to discuss beaver management related to Giardia in the Missoula water supply.
- 13 March Reviewed a 41-page manuscript for the Idaho State Museum.
- 19 March Met with Vice Presidents for Research and the wildlife faculties of MSU and UM to discuss cooperation between the two universities.
- 1 April Held a 2-day workshop with Corey Gray to teach four ADC agents netgunning for possible wolf control. Caught 12 mountain sheep for practice and turned them over to the Montana Department of Fish, Wildlife and Parks for transplanting.

- 5-9 April Netgunned and instrumented 18 deer in Everglades National Park for the University of Florida as part of the endangered Florida panther study.
- 10 April Gave a slide lecture at the International Film Festival on information and training needs in India, Nepal, and Pakistan regarding wildlife (approximately 50 participants).
- 14 April Gave a slide presentation on livestock predation to a wildlife management class (40 undergraduate and 5 graduate students).
- 16 April Spoke to the UM Chapter of TWS on trapping and drugging wildlife (60 undergraduate students and 15 graduate students and professors).
- 25 April Met with members of Friends of the Rattlesnake and the Nature Conservancy to plan acquisition of more elk winter range near Missoula.
- 27 April Gave a slide presentation on western China to the Ravalli County Sportsmen's Club in Hamilton, Montana (80 members attended).
- 5 May Gave a 2-hour slide program on China at the Hot Springs, Montana, high school (80 students, teachers, and townspeople).
- 8 May Spent day on the CSKT Reservation finding potential sites for trapping and planting mountain sheep.
- 21 May Took "Red" Duke and his filming crew to the National Bison Range to gather footage for a Boone & Crockett film to raise money to endow a wildlife chair at UM.
- 2 June Spent day on the National Bison Range hunting and necropsying a sick mountain goat.
- 13 June-1 August (On leave) In China, spent 3 weeks collecting museum specimens on the Tibetan Plateau; negotiated and signed (for UM President Koch) a Sister Institution Agreement between UM and the Western Plateau Institute, Academia Sinica, Xining. Presented a paper, "Harvesting Qinghai Ungulates--a Better Way" at the International Wildlife Conference on Wildlife Conservation in China, Beijing. Gave 10 slide-assisted lectures: "Capturing large mammals with nets and traps; drugs and drugging systems for wildlife capture; hunting/conservation programs in Pakistan and

Nepal; game ranching in Zululand, the Transvaal, Namibia, and Zimbabwe; a comparison of wildlife management in England, North America, Norway, and Russia--Capitalism to Communism and everything in between; the downfall of wildlife in Japan; hunting programs in Outer Mongolia and Russia; reproductive behavior of Montana big game; management and allowable harvest of Montana big game; and problems with wildlife management in China from an American's standpoint" at the NE Forestry Institute, Harbin. Spent a week visiting hunting reserves along the Siberian border and advising on facilities, catering to western hunters, and allowable harvests.

- 12 August Evaluated the feasibility of capturing pronghorns on the east side of the CSKT Reservation and translocating them to Ferry Basin on the west side.
- 17-18 August Visited USFWS Region Six headquarters in Denver to discuss wolf problems and Cooperative Education agreements.

Joe Ball, Assistant Unit Leader

- 1-2 October Presented a 3-hour lecture on additive and compensatory mortality to a UM wildlife class and accompanied a field trip to the Flathead Valley (30 students).
- 17-18 November Attended a 2-day meeting in Jackson, Wyoming, to help the RMP Trumpeter Swan Committee develop the management chapter of the RMP Swan Monograph.
- 24 November Lectured to the UM Montana wildlife class on waterfowl and upland game birds (30 students).
- 4 December Attended Flathead Valley Canada Goose meeting.
- 9 December Met with MT FWP personnel in Malta, Montana, regarding Central Flyway nest structure project.
- 15 December Refereed a 14-page manuscript for J. Wildl. Manage.
- 20 December Refereed a 15-page manuscript for the J. Wildl. Manage.
- 16 January Attended a meeting at the National Bison Range to discuss recruitment of ducks in the Flathead Valley.

- 29 January- Constructed goose nests in Malta, Montana, as part
9 February of the Central Flyway Nest Structure Project.
- 11-12 February Attended the Montana Chapter meeting of TWS,
Kalispell, Montana.
- 9 March Refereed a 19-page article for J. Wildl. Manage.
and a 91-page article for OIT.
- 13 March Attended meetings on the National Bison Range and
in the Flathead Valley concerning waterfowl
research.
- 17 March Refereed a 24-page manuscript for the Wildl. Soc.
Bull.
- 19 March Met with vice presidents for research and the
wildlife faculties of MSU and UM to discuss
cooperation between the two universities.
- 2 April Lectured to UM class, Wildlife Management Issues,
on upland nesting waterfowl concerns (53
students).
- May-July Conducted 2 studies requested by the Central
Flyway Technical Committee, one on the use of
artificial nest structures for mallard production
and one on duck recruitment ratios in a low-
predator environment.
- 18-22 August Attended a symposium on the ecology and management
of breeding waterfowl in Winnipeg and co-chaired a
session entitled "Parameters of
reproduction/general biology."
- 20 August Reviewed a 6-page manuscript for OIT.
- 23 August Refereed a 10-page manuscript for the J. Wildl.
Manage.
- 29 & 30 Lectured to UM class, Advanced Wildlife
September Conservation, and conducted field trip (30
students).

Andy Sheldon

- April Participated in international workshop on stream
ecology (comparison of temperate and tropical
streams), Yellow Bay, Montana.
- June Presented paper on "Fish diets and food guilds in
southeastern blackwater streams" at the annual
meeting, North American Benthological Society,
Orono, Maine.

June Presented paper on "Freshwater fishes: patterns of diversity, rarity and risk." Annual meeting, Society for Conservation Biology, Bozeman, Montana.

Chris Servheen

11-12 February Attended Montana Chapter TWS in Kalispell, Mont. and presented a paper titled "The Management of the Grizzly Bear on Private Lands: Some Problems and Possible Solutions."

Guy Connolly and Bart O'Gara

28-29 April Presented a paper, "Aerial hunting takes sheep-killing coyotes," at the Eighth Great Plains Wildl. Damage Control workshop, Rapid City, S.D.

Dan Edge

29 January Presented a seminar to the Biology Department, Univ. of Texas at Tyler entitled "Wildlife Research In Pakistan."

23 March Presented a seminar to the Wildlife and Fisheries Sciences Program at Mississippi State University entitled "Wildlife Conservation Problems in Pakistan."

Susan Ball

12-13 February Attended annual meeting of the Montana Chapter of TWS in Kalispell, Mont., and presented a paper entitled, "Mule deer use of agricultural lands in the Missouri River breaks."

Robin Bown

13 February Attended Montana Chapter TWS meeting in Kalispell. Presented paper entitled, "Beavers and dams: are they mutually exclusive?"

March Presented lecture to Montana Student Chapter, TWS, entitled, "Spotted owls and timber: anatomy of an endangered species."

Steve Gniadek

4 April Presented a paper on "Elk and cattle relationships on summer range in Southwestern Montana" at the Pacific Northwest Bird and Mammal Society-Inland Section meeting at Missoula, MT.

Steve Knick

- 3-4 April Attended Fourth Northern Furbearer Conference, Juneau, Alaska and delivered a paper entitled "Harvest strategies for bobcats."
- 23-24 June Attended a program review for the Department of Energy Ecology program at Idaho National Engineering Laboratory Site. Gave a presentation on bobcat research.

Sandra Kratville

- 21 November Attended Idaho Section meeting, Society of Range Management, Pocatello, Idaho.
- 20-21 February Attended Idaho Chapter meeting, the Wildlife Society, Boise, Idaho.

Steve Nadeau

- December Presented program to the UM Chapter of TWS entitled "Situations conducive to grizzly-human confrontations in Glacier Park."
- 12-13 February Attended Montana Chapter of TWS meetings in Kalispell, Montana.
- April Presented paper to the Symposium of Bear-People Conflicts in Yellowknife, NWT, Canada, entitled: "Movements of grizzlies near a campground in Glacier Park, Mont."
- July Presented paper to the annual Border Grizzly/Wolf Technical Committee meetings, Condo, Mont.



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Unit personnel and students helped the U.S. Fish and Wildlife Service translocate 42 bighorns, 24 Rocky Mountain goats, and 6 pronghorns during 1987. These animals were driven to drive nets by a helicopter or netgunned from a helicopter by the Unit leader.

Photo by Andrea Easter-Pilcher



The use of a helicopter and net gun provides an efficient and flexible means for capturing wild ungulates. However . . .

. . . rough terrain and demanding flight requirements leave little margin of safety in cases of mechanical failure. Fortunately, only minor injuries resulted when this machine crashed during mule deer capture operations along the upper Missouri River breaks.

Photos by Montana
Power Company





Elk in the Gravelly Range of southwestern Montana appeared to tolerate cattle only in low densities and segregate from them by use of higher elevations than where the cattle grazed.

Photo by Bart O'Gara